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Benthic Invertebrates and Data Reporting Chemical, Physical and Chlorophyll Concentrations of the Klamath, Smith, and Trinity River Systems California

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As part of the Klamath Basin Comprehensive Study, benthic invertebrate surveys were conducted of the Trinity River System in May, August, and October, 1968, and of the Smith and Klamath Systems in May, 1968. The majority of the organisms enumerated were those which spend a relatively long period of their lives in an aquatic environment and which require clean water, high in dissolved oxygen. Accompanying chemical, physical and chlorophyll data are included. All the findings suggest that the Trinity, Klamath, and Smith are clean water systems.

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BENTHIC INVERTEBRATES AND DATA REPORTING CHEMICAL, PHYSICAL AND CHLOROPHYLL CONCENTRATIONS

of the

KLAMATH, SMITH,
and
TRINITY RIVER SYSTEMS
CALIFORNIA

by

ARTHUR NOBLE

DRAFT

Abstract

As part of the Klamath Basin Comprehensive Study, benthic invertebrate surveys were conducted of the Trinity River System in May, August, and October, 1968, and of the Smith and Klamath Systems in May, 1968. The majority of the organisms enumerated were those which spend a relatively long period of their lives in an aquatic environment and which require clean water, high in dissolved oxygen. Accompanying chemical, physical and chlorophyll data are included. All the findings suggest that the Trinity, Klamath, and Smith are clean water systems.

USDI, FWPCA
Alameda, California
September, 1969

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INTRODUCTION

The Klamath Basin Comprehensive Study included benthic invertebrate surveys of three river systems. The Trinity River was sampled during May, August and October, 1968, in order to reflect conditions in the spring, summer, and fall. The Smith and Klamath Rivers (including tributaries) were examined in August (chemical data were collected in May; chlorophyll levels were tested in May and August). → benthic chlorophyll & planktonic

METHODS

Station locations are shown in Figures 1 and 2, and are listed in Tables 1, 2, and 3. Trinity stations were sampled three times; the others, once.

Benthic samples were collected using a modified Needham screen technique (details are presented in Appendix 1), then screened through a US 35 sieve (0.495 mm openings), and preserved with 10% formalin. One composite screen sample was collected at each station. This composite represented 32-48 square feet of river bottom.

In the laboratory, preserved benthic samples were rinsed in a US 50 sieve (0.295 mm openings), and spread in a shallow white tray. All invertebrate organisms were picked from debris, sorted, placed in individual vials of 70% alcohol, and taped together to await identification. Preliminary identification and counts were made. Then all samples were combined, grouped to taxon, and re-checked for final identification. Classification schemes used were those reported in Pennak (12), Usinger (16), Burks (4), Claassen (5), Parrish (11), and Ward and Whipple (17).

Samples for physical and chemical analyses were collected and tested by the standard [following] procedures described in Standard Methods (1).

Chlorophyll was measured by relative fluorescence (7). The sample was filtered through a Whatman Grade GFC filter, ground, extracted with 90% acetone, and read on a Turner Fluorometer, Model III, 3x slit, with a primary filter of 420 mμ, a secondary filter of 658 mμ, and a mercury vapor light source (mercury line of 436 mμ).

Units of relative fluorescence were calculated by the following formula:

(1) $Fu = \frac{V_E \cdot D \cdot R}{V_S}$ Where Fu = fluorescence units, V_E = volume of extract, D = reciprocal of the dilution, R = dial reading before acidification, and V_S = volume of the sample.

The units reported include both chlorophyll a and phaeophytin. To determine the relative fluorescence of chlorophyll a alone, one may use the Carpenter modification of a formula reported in Yentsch (18).

(2) $F_{chl} = 1.76 \ (F_o - F_a)$, Where F_{chl} = fluorescence of chlorophyll a, F_o = dial reading before acidification, and F_a = dial reading after acidification. F_{chl} then may be substituted for R in Equation (1) to obtain relative fluorescence of chlorophyll a in the sample.

The weight of chlorophyll in mg/m^3 was calculated by extrapolation of a curve in a graph in which the weight of chlorophyll extracted was plotted against fluorescence units.

RESULTS - TRINITY RIVER

Tables 4, 5, and 6 summarize, by month of survey, some of the benthic data (clean-water organisms/total - numbers of genera and of animals), chemical data (total phosphorus, dissolved oxygen, and total dissolved solids), and chlorophyll results. The distribution of clean water forms* varied by month. In parentheses are the numbers of clean-water groups (of either genera or population) divided by total number (of either genera or population) and expressed as percents: May, genera = 9-18 (48% - 80%), [median = 64%], total population = 33-645 (39% - 88%), [median = 87%]; August, genera = 11-20 (53% - 74%), [median = 59%], total population = 105 - 1395 (17% - 74%), [median = 62%]; October, genera = 7-19 (35% - 73%), [median = 55%], total population = 83-719 (13% - 90%), [median = 62%].

The actual numbers and kinds of benthic invertebrates obtained from all samples (May, August, October, 1968) are presented in Appendix 2, Tables 1-3. Physical, chemical and algal data obtained by field and laboratory analyses are shown in Appendix 2, Tables 4-6.

The chemical data furnished in Tables 4, 5, 6, 7 and in Appendix 2, Tables 4-6 show that the water in the system in October meets the standards for public water supply, as given in Water Quality Criteria (6) (i.e., for those chemical parameters reported in this survey). Total phosphorus levels do not exceed 50 µg/l; total dissolved solids are less than 500 mg/l; dissolved oxygen levels are greater than 4 mg/l; total nitrogen as nitrogen is less than 10 mg/l. The May and August data meet the recommended standards

* Caddisflies, stoneflies, mayflies, damselflies, gill-breathing snails (2), (6), (7), (8), (9), (10)

(for public water supply) except for level of total phosphorus. Water Quality Criteria (6) recommends a guideline of 0.10 mg/l total phosphorus concentration as desirable for rivers (desirable in that excess plant growth would not occur). At only one time in the entire study was this level exceeded (0.115 at Station 41 in August), and this relatively higher value was not repeated for the same station at either of the other two sampling times.

RESULTS - SMITH AND KLAMATH SYSTEMS (including tributaries)

Benthic data presented in Table 8 and Appendix 2, Tables 7 & 8, show that the numbers of genera vary from 11-28 (median = 20.5) for the stations in the Klamath Basin Area and from 12-16 (median = 15) for stations in the Smith River. Total numbers of animals observed very from 92-7077 (median = 354) for the Klamath area and from 118-407 (median = 221) for the Smith.

Genera of clean-water organisms per station for the Klamath range from 8-15 (42% - 79% of total, median = 60%); total numbers of clean-water benthic animals per station are 72-2399 (10% - 95% of total, median = 62%). In the Smith River numbers of clean-water genera per station are 7-11 (53% - 73% of total, median = 61%) and total numbers of clean-water benthics are 43-207 (26% - 51%, median = 33%).

It should be noted that, since the selection of sampling sites was not random and since the bottom characteristics of a river are not uniform in any given direction (15), it is pointless to compare actual numbers of animals recovered from one site with those from another. General relationships, however, may be observed.

Table 9 shows the relative proportions of selected benthic organisms recovered from two surveys - one in 1934 (15) and the other in 1968. Percentage populations of caddisflies, mayflies and stoneflies are similar for 1934 and 1968. The proportion of true flies and of snails has shifted (true flies - 31.5% in 1934 and 56% in 1968; snails - 20.2% in 1934 and 5% in 1968). This could be due to chance or to factors such as non-random sampling (the 1934 samples might have been collected in areas richer in

organic substrates than were the 1968 stations - this would increase the proportion of snails. The high percent of true flies in 1968 was due primarily to two high counts - 4000 true midges at Station 11 and 2596 black flies at Station 7. These two counts represented $\frac{6596}{8268}$ = 80% of the total population of true flies) and sample size being too small (1934 results are based upon 48 collections; 1968 data are based upon 12 collections).

Chlorophyll levels for the Klamath vary from 0.8 to 7.0 mg/m^3 in August, (Table 8), and from 0.8 to 25.1 mg/m^3 in May (Table 10). Data presented in the same tables for the Smith show levels of 0.4-0.6 mg/m^3 in August and of 1.3-3.6 mg/m^3 in May.

In August the chlorophyll concentrations are typical of most inland waters (< 10 mg/m^3). Higher values in May for the Klamath might reflect an increased amount of nutrients brought into the system by runoff.

Chemical and physical data are presented in Table 10 (extracted from Appendix 2, Tables 9, 11). All the parameters were tested during the May survey; however, only a few of them were reported for August. In May for the Klamath the DO ranged from 7.2 to 11.05 mg/l, total dissolved solids from 45-410 mg/l, total phosphorus from 0.020 to 0.200 mg/l, total nitrogen from 0.17 to 0.70 mg/l. The Smith River showed the following concentrations during May: DO, 10.3 - 10.6 mg/l; total dissolved solids, 60 - 75 mg/l; total phosphorus, 0.02 - 0.075 mg/l; total nitrogen, 0.11 - 0.67 mg/l. No Smith River chemical-physical data were available for August. Total nitrogen reported for the Klamath in August ranged from 0.1 - 0.56 mg/l.

RESULTS - General

Abstracted (from Pennak and others) details of the generation times and respiratory characteristics for various observed benthics are presented in Appendix 3. The general profile shows that the majority of the organisms identified in all the surveys are those which have a long life period in the water and which require either clean substrates or high dissolved oxygen levels.

DISCUSSION - General

Benthic surveys of stream fauna are useful in water quality assessment, since many of the different kinds of organisms that normally inhabit clean, flowing waters are sensitive to pollution. The effect of pollution may be demonstrated either by a change in population types or by a marked reduction in overall numbers. Since a given organism may exist in a stream for periods varying from a month to several years, benthic communities may provide also a long-term record of water quality.

The five basic parameters concerned in the evaluation of benthic data from screen samples are as follows:

1. The kinds and relative abundances of the organisms obtained are compared with those normally found in clean-water streams. Particular attention is given to the genera of mayflies, stoneflies, and caddisflies and to the families of true flies (Diptera). In this study the families enumerated in the Order Diptera include Blepharoceridae (net-winged midges), Tipulidae (craneflies), Simuliidae (black flies), Chironomidae (true midges), Stratiomyiidae

(soldier flies), Rhagionidae (snipe flies), Dolichipodidae (long-legged flies), Empididae (dance flies), Deuterophlebiidae (mountain midges), Heleidae (biting midges), Muscidae (house flies), and Tabanidae (horse flies).

2. The kinds and relative abundances of organisms obtained are compared also with those which are sensitive to pollution and with those that are pollution-tolerant. Mayflies, caddisflies, stoneflies, damselflies and gill-breathing snails are considered clean-water organisms; whereas pollution-tolerant types include larvae from various families within the Order Diptera (2), (8), (9), (10), (12), (13).
3. The presence, absence, and abundances of organisms having a very long (months to years) or very short life cycle (< 1 month) are noted.
4. The kinds and abundances of the organisms present are compared with physical and chemical data from the area sampled.
5. The kinds and abundances of the organisms present are compared with the existent algal populations.

Many authors have attempted to divide benthic organisms into groups according to their tolerances to pollution. Clean-water organisms include caddisflies (2), (8), (9), mayflies (2), (8), (9), stoneflies (2), (9), damselfly nymphs (13), gill-breathing snails (2), (9), (8), (10), (12); pollution-tolerant groups include the midges (red midges) (2), (8), (13) and oligochaete worms (2), (9), (13).

Certain reports are more specific in their categories (8), (13). Among the clean-water forms are the caddisflies (13) Brachycentridae, Helicopsychidae, Hydropsychidae, and Oecetis sp. and the mayfly (13) Heptagenidae. Organisms of medium tolerance to pollution are the mayflies Baetidae and Tricorythodes (13); and dance fly Hemerodromia sp. (13); the black fly Simulidae (13); the green midges (13); certain clams and snails Perrissia sp. (13), Fluminicola fusca (13), Parapholyx sp. (13), Musculium sp. (13), Pisidium sp. (8) (13), physid snails (13); certain crustaceans - an isopod - Asellus communis (13) - and an amphipod - Hyalella sp. (13).

This type of segregation can become confusing - especially when authors either disagree about the placing of an organism or describe environmental requirements in very general terms (i.e., "clean-water", "moderately tolerant", "pollution-tolerant"). Unless a stream condition is extremely bad (e.g., all pollution-tolerant forms - such as sludgeworms, red midge larvae and no clean-water forms), one must look at total relationships in order to make any conclusions about water quality.

Bartsch and Ingram (2) graphically depict clean and polluted water and characteristic numbers of kinds and total populations of animals: clean water has 10-40 species (including fish and plankton as well as benthics) per square foot and a population of 1000-4000 per square foot; polluted water has 5-10 species per square foot and 1000-10,000 total population. Since the data contained within this report do not reflect random sampling and include neither fish and planktonic forms nor listings by species, the actual populations and species reported may be low, (when compared with Bartsch and Ingram's scale).

DISCUSSION - TRINITY RIVER

The benthic invertebrate fauna found in the Trinity River System are typical (both in numbers of taxa and of total animals) for clean, cool, fast-flowing river waters in the western United States. The majority of organisms found were those which are sensitive to low levels of dissolved oxygen.

According to Pennak (12), the larvae of the stoneflies, mayflies and caddisflies are found only where the level of dissolved oxygen is high. Various genera within these families are found in specific habitats - such as quiet waters, swift waters, mud, rocks, etc. Such details will be omitted from this discussion, however, since all the forms require clean water with ample oxygen.

Both the crane fly and true midge larvae may have adaptations which enable them to live in conditions of low oxygen tension. Crane fly larvae (with the exception of one species) have a disc with spiracles which can be pushed above the surface of the water to take in air. True midge larvae of the most abundant species have a respiratory pigment (similar to hemoglobin) dissolved in their blood. Neither of these forms is limited to a polluted environment, however, so their presences probably reflect the abundances one would expect in a clean-water system.

Pollution-tolerant forms may be found in the Family Tubificidae within the general group roundworms (Oligochaeta). Usually large numbers of this family appear in polluted water. Pennak (12) reports that they can survive in anaerobic conditions for an extended period of time but not indefinitely. He further states that concentrations can exceed 8000 animals

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per square meter. The surveys reported in the present paper show a high of 114 individual roundworms (not identified to family) during August at Station 38. Since the area studied was 38-42 square feet, the concentration of about 28/m^2 is at a very low level compared with that for polluted condtions. One may conclude that the observed concentration is normal for a clean-water stream.

When the Bartsch and Ingram scale (2) is used to analyze numbers of kinds and total populations, the following results are obtained. In May the numbers of genera per station are 17-21 (median = 20), the populations, 134-850 (median = 360); August, genera are 19-30 (median = 23), populations, 582-1944 (median = 872); October, genera are 20-26 (median = 23), populations, 285-1671 (median = 543). Each station fits the range expected for clean water (10-40 species). The total populations are low (expected 1000-4000 per square foot). As was mentioned earlier though, the population figures listed in (2) include fish and plankton as well as benthics. Therefore, these reported ranges probably still indicate clean water.

Another consideration in evaluation of stream quality is the length of the life cycle of the organisms present (especially noted is the time spent in the aquatic environment - since many animals may live part of the time as larvae or nymphs in the water and then may exist for the remainder of their lives as terrestial forms). Some of the fauna described in the surveys have no generation times listed in the literature. Of those groups which are described, only the black flies may have a

larval stage of one month or less. The preponderance of the organisms observed have nymph or larval stages which extend for months to years. The following animals are said by Pennak (12) or Usinger (16) to fall into the long-life-cycle group (usually): crane flies, true midges, caddisflies, mayflies, stoneflies, aquatic moths, beetles (including water pennies, riffle beetles, and predaceous diving beetles), dragonflies, damselflies, alderflies, and snails. The majority of these long-cycle organisms also require clean substrate and/or [high] dissolved oxygen levels. at or near saturation

When the chemical and physical characteristics of the Trinity System are reviewed, it is apparent that clean, high quality water is being described. The one time (August - Station 41) that the total phosphorus concentration exceeded suggested limits for natural waters, the corresponding nitrogen level was low (total nitrogen 0.28 mg/l), and no deleterious effects were reported.

The final parameter listed for evaluation of water quality is observation of planktonic algal concentrations or of chlorophyll levels. Various authors (Holm-Hansen [7]; Burkholder and Burkholder [3]; Strickland [14]) list chlorophyll values for the oceans. These amounts usually range from 0.1 - 1 mg chlorophyll a/m^3.

Studies done in the laboratory during 1968 show the following values for chlorophyll a for selected California rivers:

Truckee	1.4 - 7.0 mg/m^3
San Joaquin	6.6 - 7.0 mg/m^3
Merced	12.7 - <17.4 mg/m^3
Tuolumne	<17.4 mg/m^3

Laboratory experience has shown also that the following ranges generally apply:

Open ocean and Lake Tahoe	≤ 1 mg/m^3
Most inland waters	<10 mg/m^3
Lakes, bloom conditions	>10 mg/m^3
Lakes, eutrophic	25-35 mg/m^3

The range of concentrations obtained in the October survey of the Trinity System was 1.1 - 4.9 mg chl a/m^3. At no time in the other two surveys did the chlorophyll a level ever exceed 3 mg/m^3. This range of values would suggest that the Trinity is a river system which has chlorophyll values similar to those for the Truckee.

DISCUSSION - KLAMATH AND SMITH RIVERS (and tributaries)

Table 8 shows total numbers of genera and population levels observed at various stations. At each sampling point there are more than 10 genera reported (which would indicate that at least 10 species were present), and, of these, the majority are clean-water organisms (exceptions occur at Stations 18 [48%] and 11 [42%] - but the percentages are still close to 50%).

When numbers of benthic organisms with long-life cycles (see earlier discussion of Trinity River results) are compared to the total populations observed at each station, the long-life-cycle types are in the majority (The only exception is at Station 7 - Bluff Creek near confluence with Klamath. A huge population of black flies - 2596 flies/3114 total benthics - comprises the majority of the population). With the omission of Station 7 the percent of long-life-cycle organisms ranges from 84% - 100% (median = 97%). The fact that a high proportion of this group of organisms is present in the Klamath and Smith Systems suggests that the water quality is clean enough to support benthic populations over time periods ranging from months to years.

Water Quality Criteria (6) states that phosphorus level is an important parameter for a river. Allowable amounts may vary, depending upon such things as turbidity, temperature, and type of bottom; however, a level of 0.100 mg P/l is recommended for rivers in general.

Ratio of nitrogen to phosphorus is important also. Water Quality Criteria (6) states that 10:1 is the usual relationship for nitrogen to phosphorus in natural water under normal conditions.

Data presented for the Smith in May show acceptable phosphorus and nitrogen:phosphorus levels for each station. The Klamath in May has higher concentration at certain stations: Station 13 exceeds the recommended ratio $\left(\frac{N=0.45\ mg/l}{P=0.03\ mg/l}\right) > 10$, but phosphorus is below 0.100 mg/l; Stations 15 $\left(\frac{N=0.46\ mg/l}{P=0.20\ mg/l}\right)$ and 18 $\left(\frac{N=0.53\ mg/l}{P=0.11\ mg/l}\right)$ do not have a ration greater than 10:1 but do exceed the recommended phosphorus level. Since the corresponding chlorophyll concentrations are above 10 mg/m^3 (the normal value for inland waters) for Stations 13, 15, 18 (levels of 10.0, 17.2, 25.1, respectively), it may be concluded that these reported chemical levels may lead to algal-bloom conditions. The increase could be due to addition of nutrients by spring runoff. In August both the Klamath and Smith show chlorophyll levels below 10 mg/m^3 (in fact, the Smith shows concentrations below 1 mg/m^3- putting it in the same range as is shown by open oceans and Lake Tahoe).

August chemical data is not available at all for the Smith and not for some of the stations in the Klamath. However, the two reported Klamath stations, 11 (July 31, 1968) and 15 (August 13, 1968), which again show higher total phosphorus concentration do not reflect this in high chlorophyll levels - both have values below 10 mg/m^3.

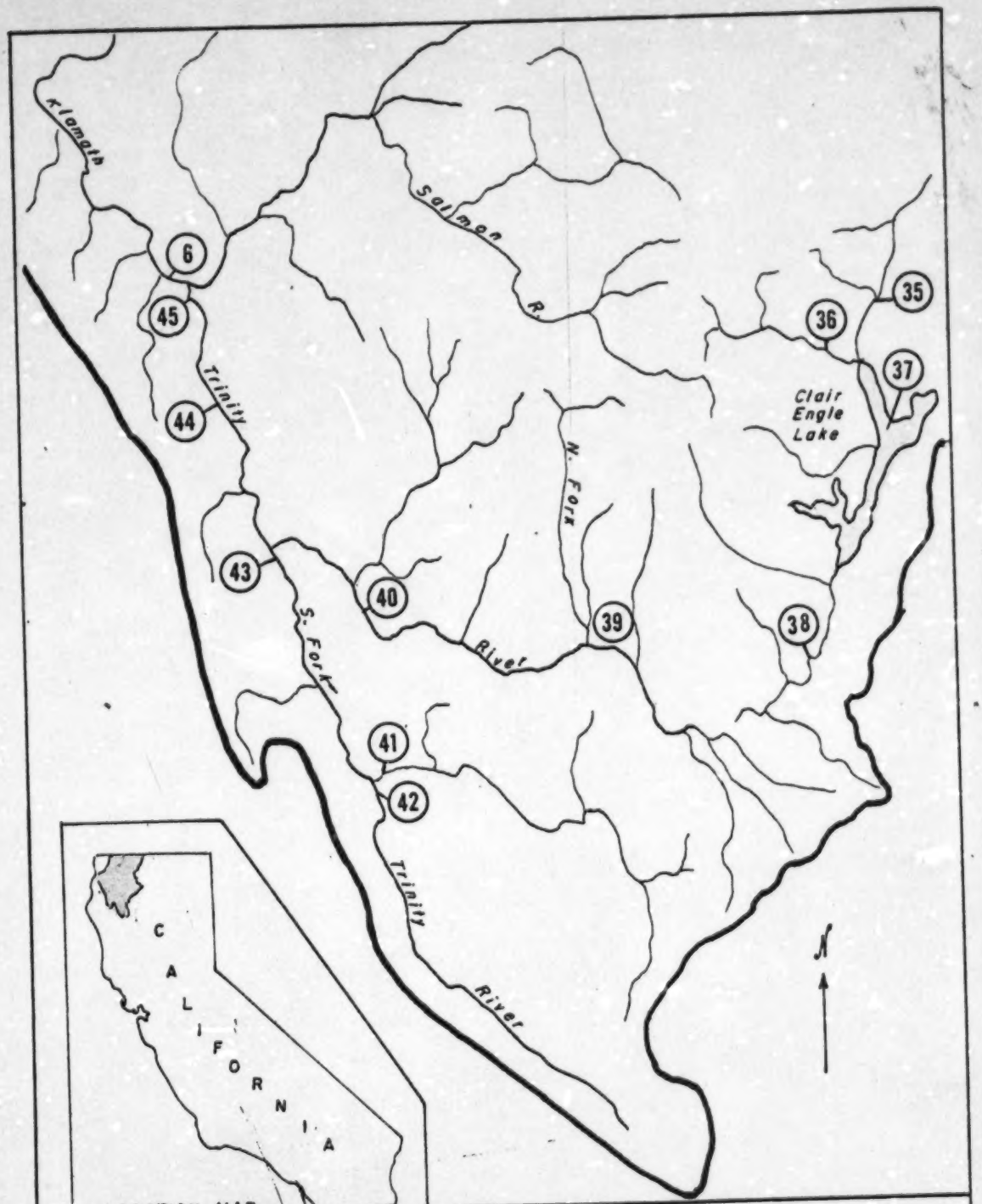
Those chlorophyll concentrations reported show a range from 7.0 to 3.2 mg/m^3 for the Klamath and from 0.6 to 0.4 mg/m^3 for the Smith. Both of these ranges are within the scope expected for normal inland waters (chlorophyll a less than 10.0 mg/m^3).

When the Klamath System in 1968 is compared with that described in 1934 (Table 9), the proportions of reported benthic organisms are

similar. Possible explanations for the two departures from the pattern (snails, true flies) have been offered previously in the Results Section.

CONCLUSIONS

On the basis of the physical, chemical and benthic parameters discussed, it may be concluded that the Klamath, Smith and Trinity Rivers (including their tributaries) are clean-water systems. The ranges of benthic organisms observed are those which one would expect in such systems - the majority of fauna reported are those animals which spend a relatively long period of their lives in an aquatic environment and which require clean, highly-oxygenated water. When proportions of benthic organisms identified in 1934 for the Klamath System are compared with those recovered in the 1968 survey, percentage distributions in general are similar.



TRINITY RIVER
STATION LOCATIONS

U.S. DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
PACIFIC SOUTHWEST REGION SAN FRANCISCO, CALIF.

FIGURE 1

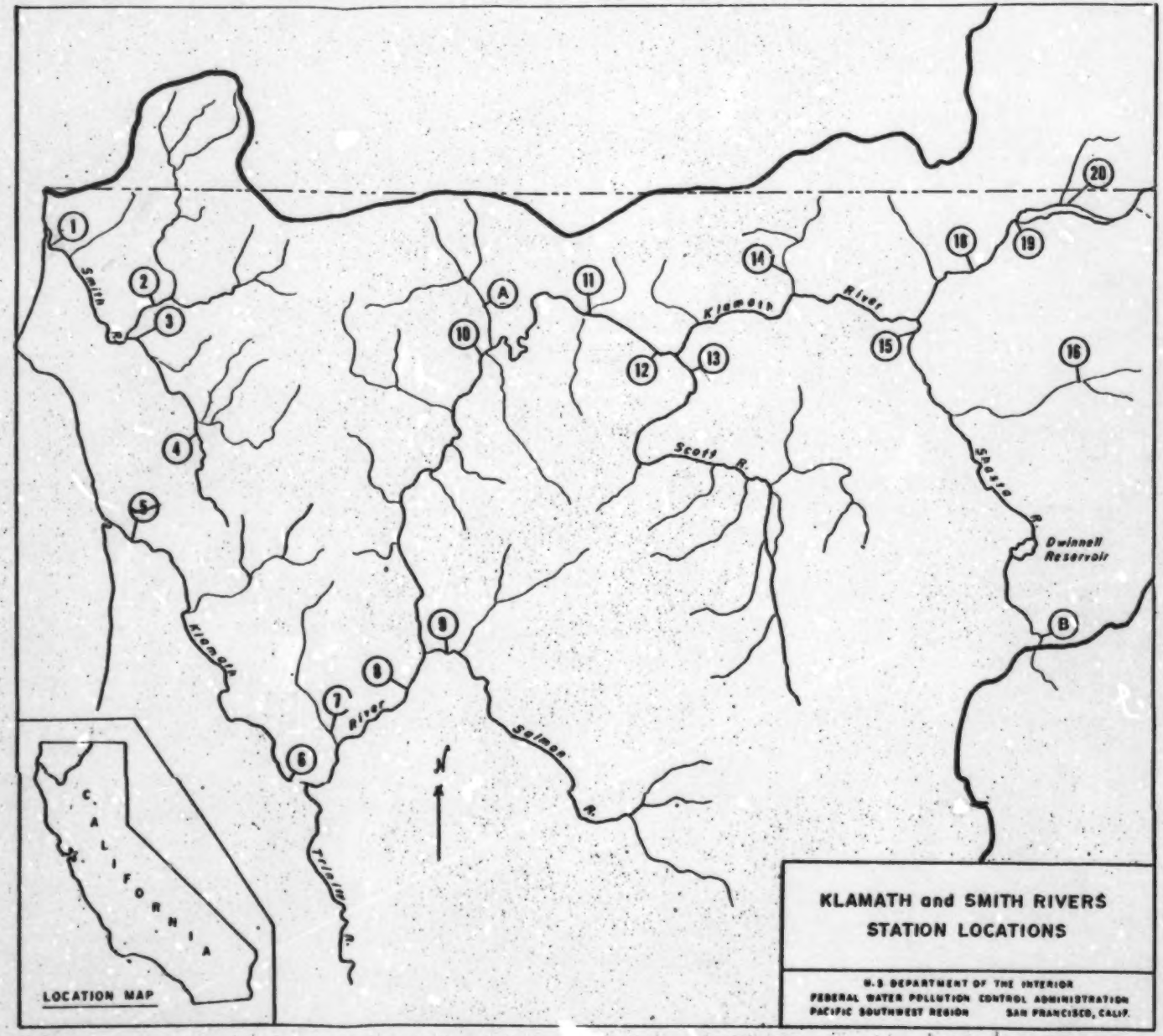

Smith R.
Klamath River
Scott R.
Shasta R.
Dwinnell Reservoir
Klamath River
Salmon R.
Trinity R.
N
CALIFORNIA
LOCATION MAP
KLAMATH and SMITH RIVERS
STATION LOCATIONS
U.S DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
PACIFIC SOUTHWEST REGION SAN FRANCISCO, CALIF.

FIGURE 2

Table 1

SAMPLING STATIONS, TRINITY RIVER

Number	Station	Abbreviation
35	Trinity River above Trinity Center	TR-TC
36	Coffee Creek	CC
38	Trinity River - Lewiston	TR-L
39	North Fork Trinity - Helena	NFT
40	Trinity River - Burnt Ranch	TR-BR
41	Hayfork Creek - Hyampom	HC-H
42	South Fork Trinity River - Hyampom	SFT-H
43	South Fork Trinity River - Salyer	SFT-S
45	Trinity River - Weitchpec	TR-W
6	Klamath River - Weitchpec	KR-W

what happened to Hoopa?

Table 2

SAMPLING STATIONS, SMITH RIVER

Number	Station	Abbreviation
1	Smith River - Jedediah Smith Park	SR-Jed
2	Middle Fork Smith River - Gasquet	MFS
3	South Fork Smith River - Gage	SFS
4	Goose Creek	GC

Table 3

SAMPLING STATIONS, KLAMATH RIVER

Number	Station	Abbreviation
6	Klamath River - Weitchpec	KR-W
7	Bluff Creek - Confluence Klamath River	BC-KR
8	Klamath River - Orleans	KR-Orleans
9	Salmon River at Somes Bar	Sal-R
10	Klamath River - Happy Camp	KR-HC
A	Indian Creek - Happy Camp	IC-HC
11	Klamath River - Seaid	KR-Seaid
13	Scott River - Confluence Klamath River	Scott R-KR
15	Shasta River - Confluence Klamath River	Shasta R-KR
17	Little Shasta near Montague	LS-Mont.
B	Shasta River - Edgewood	Shasta R-E
18	Klamath River - Klamathon	KR-Klam.

Table 4: Selected Benthic and Chemical Data, by Station Number, Trinity River, May, 1968**

Station	Clean Water Organisms*/Total #Genera/Total	Clean Water Organisms*/Total #Animals/Total	Total Phosphorus mg/l	D.O. mg/l	T.D.S. mg/l
35 TR-TC	14/18 (78%)	117/134 (87%)	0.035	10.4	55
36 CC	16/20 (80%)	645/736 (88%)	0.055	11.0	50
38 TR-L	9/19 (48%)	33/850 (39%)	0.035	11.6	60
39 NFT	18/28 (64%)	230/360 (64%)	< 0.02	10.6	30
40 TR-BR	15/23 (65%)	402/795 (51%)	0.02	10.8	60
41 HC-H	12/20 (60%)	273/453 (60%)	< 0.02	10.4	160
42 SFT-H	12/17 (71%)	203/234 (87%)	0.065	10.4	105
43 SFT-S	13/21 (62%)	199/230 (87%)	0.065	11.0	130
45 TR-W	12/21 (57%)	216/249 (87%)	0.075	10.4	100

* Caddisflies, stoneflies, mayflies, damselflies, gill-breathing snails. (2),(6),(7),(8),(9),(10)

** Data extracted from Tables 1, 4, Appendix 2

Table 5: Selected Benthic and Chemical Data, by Station Number, Trinity River, August, 1968***

Station	Clean-water Organisms*/Total #Genera/Total	#Animals/Total	Total Phosphorus mg/l	D.O. mg/l	T.D.S. mg/l	Chlorophyll Fu**	Chlorophyll Wt mg/m^3
35 TR-TC	20/27 (74%)	419/1015 (41%)	< 0.02	9.0	105	2.2	1.5
36 CC	15/21 (71%)	516/755 (68%)	<	9.0	95	1.8	1.3
38 TR-L	13/22 (59%)	105/623 (17%)	0.035	11.2	60	4.0	2.8
39 NFT	15/26 (58%)	670/1076 (62%)	0.085	8.8	70	1.8	1.3
40 TR-BR	14/21 (67%)	567/872 (65%)	0.045	8.7	100	2.4	1.7
41 HC-H	16/30 (53%)	321/718 (45%)	0.115	11.0	175	3.2	2.2
42 SFT-H	14/24 (58%)	801/1361 (59%)	0.020	6.8	170	1.6	1.1
43 SFT-S	11/19 (58%)	431/582 (74%)	0.090	8.4	180	1.4	1.0
45 TR-W	16/23 (70%)	1395/1944 (72%)	0.065	9.0	140	****	****

* Caddisflies, stoneflies, mayflies, damselflies, gill-breathing snails. (2),(6),(7),(8),(9),(10)

** Fluorescence units

*** Data extracted from Tables 2, 5, Appendix 2.

**** Data unavailable

Table 6: Selected Chemical and Benthic Data, by Station Number, October, 1968, Trinity River***

Station	Clean-water Organisms*/Total #Genera/Total	Clean-water Organisms*/Total #Animals/Total	Total Phosphorus mg/l	D.O. mg/l	T.D.S mg/l	Chlorophyll Fu**	Chlorophyll Wt. mg/m^3
35 TR-TC	16/23 (70%)	348/412 (85%)	0.02	10.2	105	1.9	1.3
36 CC	19/26 (73%)	719/804 (90%)	0.02	10.4	115	7.0	4.9
38 TR-L	11/20 (55%)	223/1671 (13%)		11.0	105	4.4	3.1
39 NFT	13/21 (62%)	716/1148 (62%)	0.02	10.6	70	1.5	1.1
40 TR-BR	13/25 (52%)	200/306 (65%)	0.02	10.4	95	2.6	1.8
41 HC-H	7/20 (35%)	83/285 (29%)	0.02	11.6	210	2.2	1.5
42 SFT-H	12/23 (52%)	168/398 (42%)	0.04	9.9	180	2.4	1.7
42 SFT-S	12/23 (52%)	709/996 (71%)	0.05	10.0	215	3.4	2.3
45 TR-W	13/23 (57%)	302/543 (55%)	0.05	10.0	130	3.7	2.6

* Caddisflies, stoneflies, mayflies, damselflies, gill-breathing snails (2),(6),(7),(8),(9),(10).

** Fu = fluorescence units, described in Methods Section.

*** Data extracted from Tables 3, 6, Appendix 2.

Table 7: Total Nitrogen* and Total Phosphorus* by Station During Three Surveys of the Trinity River

Chemical Components	STATIONS 35	36	38	39	40	41	42	43	45
May Survey									
Total N	<0.28	.82	<.18	<.11	<.15	<.08	<.56	.20	.7
Total P	.035	.055	.035	<.02	.02	<.02	.065	.065	.075
August Survey									
Total N	.19	.01	.42	.15	.39	.28	.31	.28	.26
Total P	<.02	<	.035	.085	.045	.115	.02	.09	.065
October Survey									
Total N	.14	.48	.28	.32	.15	.40	.08	.16	.34
Total P	<.02	<.02	<	<.02	.02	.02	.04	.05	.05

* Concentrations are expressed in mg/l

Planktonic

Table 8: Klamath and Smith Rivers, Chlorophyll Levels and Numbers of Selected Benthic Organisms, by Station, August, 1968***

Station	Clean-water Organisms*/Total #genera/total	#animals/total	Chlorophyll Fu	Wt mg/m^3
6 (KR-W)	14/24 (58%)	719/878 (82%)	8.6	5.6
7 (BC-KR)	12/20 (60%)	310/3114 (10%)	**	**
8 (KR-Orleans)	12/20 (60%)	360/565 (64%)	8.75	6.1
9 (Sal-R)	14/20 (70%)	245/339 (72%)	1.2	0.8
10 (KR-HC)	9/12 (75%)	186/196 (95%)	8.75	6.1
A (IC-HC)	8/11 (73%)	88/339 (26%)	**	**
11 (KR-Seaid)	11/26 (42%)	239/7077 (34%)	10.0	7.0
13 (Scott R-KR)	9/15 (60%)	66/111 (59%)	6.45	4.5
15 (Shasta R-KR)	15/28 (54%)	138/369 (37%)	4.7	3.3
17 (LS-Mont)	15/19 (79%)	155/169 (92%)	**	**
B (Shasta R-E)	11/14 (79%)	72/92 (78%)	**	**
18 (KR-Klam)	12/25 (48%)	788/1568 (50%)	4.6	3.2
1 (SR-Jed)	7/12 (58%)	207/407 (51%)	0.8	0.6
2 (MFS)	10/16 (63%)	62/238 (26%)	0.7	0.5
3 (SFS)	8/15 (53%)	43/118 (36%)	0.6	0.4
4 (GC)	11/15 (73%)	61/204 (29%)	0.6	0.4

* Caddisflies, stoneflies, mayflies, damselfly nymphs, gill-breathing snails (2), (6), (7), (8), (9), (10)

** Data not available

*** Data extracted from Tables 7, 8, 10, 12, Appendix 2

Table 9: Percent Population of Selected Benthic Organisms in the Klamath System*, 1934** and 1968

Organism	Percent Population in Klamath System* 1934	August, 1968
Caddisflies	21.6	21.0
Mayflies	18.2	16.0
True flies	31.5	56.0
Stoneflies	2.3	0.3
Snails	20.2	5.0
Aquatic moths	1.9	0.3
Beetles	3.7	1.2
Damselflies & Dragonflies	0.3	0.2
Number of Collections	48	12
Total Population	18,201	14,644

* Klamath System includes Klamath, Salmon, Scott, Shasta Rivers and their tributaries

** Data from Reference 12

Table 10: Selected Chemical Data by Station, May, 1968**
Klamath and Smith Rivers

Station	Total Phosphorus mg/l	D.O. mg/l	T.D.S. mg/l	Chlorophyll Fu	Chlorophyll Wt mg/m^3
8 KR-Orleans	0.055	10.7	80	12.6	8.8
9 Sal-R	0.070	11.0	45	2.1	1.5
10 KR-HC	0.050	10.2	95	12.0	8.4
A IC-HC	0.020	11.05	60	1.2	0.8
11 KR-Seaid	0.070	7.2	175	*	*
13 Scott R-KR	0.034	10.15	95	14.4	10.0
15 Shasta R-KR	0.200	9.0	410	24.6	17.2
18 KR-Klam	0.11	10.65	125	36.0	25.1
1 SR-Jed	0.020	10.6	75	5.10	3.6
2 MFS	<	10.35	60	1.80	1.3
3 SFS	0.075	10.45	75	1.80	1.3
4 GC	0.020	9.6	75	*	*

* Data not available

** Data extracted from Tables 9, 11, Appendix 2

BIBLIOGRAPHY

1 American Public Health Association. Standard Methods for the Examination of Water and Wastewater. 12th ed. 1965.

2 Bartsch, A.F., and W.M. Ingram. Stream life and the pollution environment. Public Works: 90:7:104. 1959.

3 Burkholder, P.R. and L.M. Burkholder. Primary productivity in surface waters of the South Pacific Ocean. Limnology and Oceanography: 12:4:606. 1967.

4 Burks, B.D. The Mayflies, or Ephemeroptera, of Illinois. Natural History Survey Division. Bulletin V. 26, Article 1. State of Illinois. Urbana, Illinois. 1953.

5 Claassen, Peter W. Plecoptera Nymphs of America. Published for the Thomas Say Foundation. Charles C. Thomas, Publisher. Springfield, Illinois and Baltimore, Maryland. 1931.

6 Federal Water Pollution Control Administration. Water Quality Criteria. 1968.

7 Holm-Hansen, O. et al. Fluorometric determination of chlorophyll. J.Cons. Perm. int. Explor. Mer: 30:1:3. 1965

8 Ingram, W. M. Use and Value of Biological Indicators of Pollution: Fresh water clams and snails. Robert A. Taft Engineering Center. (Date not stated, but more recent than 1955 - the latest reference cited in paper).

9 Ingram, W. M., and W. W. Towne. Stream life below industrial outfalls. Public Health Reports: 74:12:1059. 1959.

10 Mackenthun, K.M. and W.M. Ingram. Biological Associated Problems in Freshwater Environments, Their Identification, Investigation and Control. U. S. Dept. Interior, Federal Water Pollution Control Administration. 1967.

11 Ed. by Fred K. Parrish. Keys to Water Quality Indicative Organisms (Southeastern United States) FWPCA, USDI, November, 1968.

12 Pennak, R.W. Freshwater Invertebrates of the United States. The Ronald Press Company, New York. 1953.

13 State of Oregon, Oregon State Sanitary Authority; State of California, North Coast Regional Water Pollution Control Board; USPHS, Water Supply and Water Pollution Control. Report on Investigations of Pollution in Klamath River System. 1955.

14 Strickland, J.D.H. A comparison of profiles of nutrient and chlorophyll concentrations taken from discrete depths and by continuous recording. Limnology and Oceanography: 13:2:396. 1968.

15 Taft, A.C., and L. Shapovalov. A Biological Survey of Streams and Lakes in the Klamath and Shasta National Forests of California. Dept. of Commerce, Bureau of Fisheries. 1935.

16 Usinger, R.L., Editor. Aquatic Insects of California. University of California Press. Berkeley and Los Angeles. 1963.

17 Ward, H. B., and G.C. Whipple. Freshwater Biology. Second Edition. Editor, W.T. Edmondson. John Wiley and Sons, New York, 1959.

18 Yentsch, C.S. Distribution of chlorophyll and phaeophytin in the open ocean. Deep Sea Research: 12:5:653. 1965.

APPENDIX 1

BENTHIC SURVEY TECHNIQUE

Samples were collected by use of a 36 x 18 inch Needham-type screen with 0.5 mm openings. The screen was wedged between the stream bed and the sampler's knees (sampler faced upstream). Within a four-foot-square area upstream all rocks were brush-scrubbed and all gravel roiled. This operation caused debris and organisms to be carried downstream with the current and to be trapped against the screen. Screen-entrapped material was then washed into a large bucket of water. The entire scrubbing process was repeated 8-12 times at varying depths (1-36 inches) and currents. Contents from the sample bucket were poured through a US 35 sieve (0.495 mm openings). Sieve residue was placed in jars and preserved with 10% formalin.

One composite screen sample was collected at each station per survey visit and represented usually 32-48 square feet of river bottom. Since the method is qualitative and since sampling is not random, the resulting population counts cannot be expressed (in an absolute fashion) per unit area. Relative populations may be observed however.

The modified-Needham-screen sampling technique was developed by Mr. W. Arthur Noble, a technican in the biology laboratory. He has found it superior to the Surber Sampler for reasons summarized in Table 1.

Table 1: Comparison of Surber and Modified Needham-Screen Samplers

Surber Sampler	Screen Sampler
1. Use is limited to areas with moderate current. A very slow current will not carry organisms into the net; a very swift current causes both back-pressures at mouth of net and subsequent loss of organisms.	1. Use is possible in current of any speed or depth - wherever wading is feasible.
2. The stream bed must be relatively even so that all four sides of the sample frame are in contact with the bottom. Any space between the frame and substrate allows escape of organisms. An area with large rocks could not be sampled satisfactorily.	2. A level stream bed is not a pre-requisite. Any type of substrate may be sampled (boulder, rocks, cobble, gravel, etc.)
3. Water depth must be 6-10 inches. More shallow depths will not carry organisms into net; deeper water will cover sampler and allow some of the organisms to escape.	3. The sampler can be used in depths of 1-36 inches.
4. Only a limited range of stream habitats may be sampled (use is limited by factors described in points 1-3).	4. Almost all stream habitats may be sampled.
5. Area sampled is very small (one square foot) and very selective.	5. Area sampled is relatively large (usually 32-48 square feet) and less selective.

small stream currents tend to be highly subject to modification from objects on the bottom, i.e., current speeds may vary considerably. Small floating objects seldom follow a straight line downstream, hence, materials disturbed beyond the center line of the screen enjoy a higher probability of non-capture 1) the greater the distance from the screen or 2) the closer they are to the "edge" area.

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APPENDIX 2

DATA

TABLE 1: BOTTOM ANIMALS: TRINITY RIVER SURVEY - MAY 1968

	TR above Coffee Creek	Coffee Creek	TR at Lewiston	NFT Near Helena	TR near Burnt Ranch	HC near Hyampom	SFT Near Hyampom	SFT Near Salyer	TR above KR	KR above TR
FLATWORMS (TURBELLARIA)	-	1	39	1	-	-	-	-	-	-
ROUNDWORMS (OLIGOCHAETA)	-	-	93	-	-	4	6	2	-	1
SCUDS (AMPHIPODA)	-	-	-	-	-	-	-	1	-	-
WATER MITES (HYDRACARINA)	-	-	5	3	-	7	-	-	2	-
MAYFLIES (EPHEMEROPTERA)										
Rhithrogena	-	3	-	15	16	7	2	3	8	11
Iron	18	4	10	32	14	42	-	2	-	6
Ironopsis	20	143	-	20	3	-	-	-	-	-
Ironodes	-	1	-	-	-	-	-	-	-	-
Cinygmula	13	63	-	-	-	-	5	-	-	1
Stenonema	-	-	-	-	-	6	-	-	-	1
Paraleptophlebia	2	5	-	3	1	-	-	-	-	-
Ephemerella	16	119	77	5	49	147	100	51	24	64
Tricorythodes	-	-	-	-	1	-	-	-	2	4
Baetis	24	183	215	43	81	37	15	25	100	152
Ameletus	4	14	2	12	17	7	5	19	1	1
STONEFLIES (PLECOPTERA)										
Pteronarcys	-	-	-	-	2	2	-	3	-	-
Peltoperla	-	1	-	-	-	-	-	-	-	-
Nemoura	-	1	-	-	-	-	-	-	-	-
Acroneuria	3	15	12	19	7	3	3	15	-	3
Isoperla	-	-	-	3	3	-	-	2	3	2
Alloperla	-	6	-	2	-	2	15	2	3	4
CADDISFLIES (TRICHOPTERA)										
Wormaldia	-	-	-	-	8	1	-	-	-	1
Hydropsyche	9	75	-	19	172	17	13	63	56	80
Cheumatopsyche	2	-	-	25	26	-	16	7	3	3
Rhyacophila	1	3	-	8	2	-	-	-	-	-
Glossosoma	-	9	10	16	-	-	-	-	-	-
Protoptila	-	-	-	-	-	-	26	6	9	-
Lepidostoma	3	-	1	2	-	-	-	-	-	1
Micrasema	-	-	-	-	-	-	-	1	4	-
Neophylax	1	-	-	1	-	-	-	-	-	-
Dicosmoecus	1	-	-	1	-	-	-	-	-	-
Ecclisomyia	-	-	3	-	-	-	-	-	-	-
Limnephilus	-	-	3	-	-	-	2	-	-	-
Helicopsyche	-	-	-	4	-	-	1	-	3	-
AQUATIC MOTHS (LEPIDOPTERA)										
Parargyractis	-	-	-	2	-	-	-	-	-	-
DRAGONFLIES (ANISOPTERA)										
Ophiogomphus	-	-	-	-	2	1	-	-	2	-
WATER PENNIES (PSEPHENIDAE)	-	-	-	1	1	-	-	-	-	-
RIFFLE BEETLES (ELMIDAE)	1	-	2	7	6	2	3	1	14	9
CRANE FLIES (TIPULIDAE)	2	-	42	61	6	10	10	9	1	1
NET-WINGED MIDGES (BLEPHARICERIDAE)	-	1	-	2	1	-	-	-	-	-
MOUNTAIN MIDGES (DEUTEROPHEBIIDAE)	-	-	-	1	-	-	-	-	-	-
BLACK FLIES (SIMULIIDAE)	3	12	1	3	47	-	-	1	2	7
TRUE MIDGES (CHIRONOMIDAE)	11	77	259	49	327	147	11	15	9	170
SOLDIER FLIES (STRATIOMYIDAE)	-	-	-	-	-	6	-	-	-	-
SNIPE FLIES (RHAGIONIDAE)	-	-	-	-	-	-	-	1	1	1
LONG-LEGGED FLIES (DOLICHOPODIDAE)	-	-	-	-	-	-	-	-	1	-
DANCE FLIES (EMPIDIDAE)	-	-	-	-	3	3	1	1	1	13
SNAILS (GASTROPODA)										
Goniobasis	-	-	-	-	-	2	-	-	-	1
Physa	-	-	57	-	-	-	-	-	-	-
Gyraulus	-	-	4	-	-	-	-	-	-	-
CLAMS (SPHAERIIDAE)	-	-	15	-	-	-	-	-	-	-
Number of Kinds	18	20	19	28	23	20	17	21	21	23
Number in Sample	134	736	850	360	795	453	234	230	249	537

TR = Trinity, NFT = North Fork Trinity, HC = Hayfork Creek, SFT = South Fork Trinity, KR = Klamath River

TABLE 2: BOTTOM ANIMALS TRINITY RIVER SURVEY - AUGUST 1968

	TR above Coffee Creek	Coffee Creek	TR at Lewiston	NFT near Helena	TR near Burnt Ranch	HC near Hyampom	SFT near Hyampom	SFT near Salyer	TR above KR
FLATWORMS (TURBELLARIA)	-	-	1	-	-	-	-	-	-
ROUNDWORMS (OLIGOCHAETA)	9	3	71	-	-	-	-	-	3
LEECHES (HIRUDINEA)	-	-	-	1	-	-	-	-	-
CRAYFISH (ASTACIDAE)	-	-	-	-	-	2	-	-	-
WATER MITES (HYDRACARINA)	-	-	-	-	6	122	18	-	-
MAYFLIES (EPHEMEROPTERA)									
Naptagenia	48	16	2	-	-	-	-	-	4
Rhithrogena	4	4	-	42	-	-	128	-	-
Iron	7	1	1	14	-	10	-	8	7
Ironopsis	3	26	-	-	23	-	-	-	-
Siphlonurus	-	-	-	-	-	-	-	-	4
Isonychia	-	-	-	-	46	8	47	4	70
Paraleptophlebia	1	-	2	-	-	-	-	-	-
Ephemerella	20	11	2	11	60	3	60	10	2
Tricorythodes	3	-	-	-	10	6	-	4	6
Baetis	87	298	78	74	55	17	63	159	320
STONEFLIES (PLECOPTERA)									
Pteronarcys	-	-	1	2	1	10	2	3	1
Nemoura	1	1	1	2	1	-	-	-	-
Acroneuria	15	16	4	135	4	2	117	24	4
Arcynopteryx	25	32	5	26	6	-	-	-	-
Alloperla	5	11	-	4	-	-	1	-	-
CADDISFLIES (TRICHOPTERA)									
Wormaldia	9	-	-	19	26	14	24	62	4
Polycentropus	-	-	-	-	-	-	-	-	1
Hydropsyche	107	14	-	216	302	86	252	145	944
Cheumatopsyche	-	-	-	-	-	-	61	-	12
Arctopsyche	11	10	-	2	-	-	-	-	-
Rhyacophila	32	22	-	116	23	3	10	7	14
Glossosoma	45	22	4	6	3	-	-	-	-
Anagapetus	-	32	-	-	-	-	-	-	-
Protoptila	-	-	-	-	-	3	32	5	-
Hydroptila	1	-	-	-	7	136	2	-	1
Micrasema	-	-	-	-	-	-	-	-	1
Neophylax	1	-	-	-	-	-	-	-	-
Dicosmoecus	-	-	2	1	-	2	-	-	-
Psychorina	-	-	2	-	-	-	-	-	-
Helicopsyche	-	-	-	-	-	6	2	-	-
Lepidostoma	4	-	1	-	-	-	-	-	-
AQUATIC MOTHS (LEPIDOPTERA)									
Parargyractis	-	-	-	2	24	21	3	2	2
DRAGONFLIES (ANISOPTERA)									
Ophiogomphus	-	-	-	-	4	19	2	1	-
DAMSELFLIES (COENAGRIONIDAE)	-	-	-	-	-	7	-	-	-
CREEPING WATER BUGS (NAUCORIDAE)	-	-	-	-	-	5	-	-	-
WATER PENNIES (PSEPHENIDAE)	-	-	-	1	-	3	-	-	-
RIFFLE BEETLES (ELMIDAE)	33	-	-	37	24	118	288	30	6
PREDACEOUS DIVING BEETLES(DYTISCIDAE)	-	-	-	-	-	-	-	-	-
CRANE FLIES (TIPULIDAE)	37	19	77	90	56	12	13	27	3
NET-WINGED MIDGES (BLEPHARICERIDAE)	13	15	-	1	-	-	-	5	1
BLACK FLIES (SIMULIIDAE)	429	132	20	1	-	2	2	8	-
TRUE MIDGES (CHIRONOMIDAE)	70	69	324	266	141	60	187	77	524
BITING MIDGES (HELEIDAE)	-	-	2	2	-	-	-	-	-
SOLDIER FLIES (STRATIOMYIIDAE)	-	-	-	-	-	7	27	-	-
SNIPE FLIES (RHAGIONIDAE)	5	-	-	4	31	7	16	1	10
HORSE FLIES (TABANIDAE)	-	-	-	-	-	-	4	-	-
DANCE FLIES (EMPIDIDAE)	-	-	1	1	-	-	-	-	-
HOUSE FLIES (MUSCIDAE)	-	1	-	-	-	-	-	-	-
SNAILS (GASTROPODA)									
Goniobasis	-	-	-	-	-	8	-	-	-
Physa	-	-	16	-	-	-	-	-	-
Gyraulus	-	-	-	-	-	2	-	-	-
Lanx	-	-	-	-	-	17	-	-	-
CLAMS (SPHAERIIDAE)	-	-	6	-	-	-	-	-	-
Number of Kinds	27	21	22	26	21	30	24	19	23
Number in Sample	1015	755	623	1076	853	718	1361	582	1944

TABLE 3 BOTTOM ANIMALS: TRINITY RIVER SURVEY - OCTOBER, 1968

	TR above Coffee Creek	Coffee Creek	TR at Lewiston	NFT near Helena	TR near Burnt Ranch	HC near Hyampom	SFT near Hyampom	SFT near Salyer	TR above KR	KR above TR
FLATWORMS (TURBELLARIA)	-	-	64	-	4	-	2	3	35	6
ROUNDWORMS (OLIGOCHAETA)	-	24	18	-	-	-	-	-	-	4
WATER MITES (HYDRACARINA)	-	-	-	-	-	4	-	1	-	-
MAYFLIES (EPHEMEROPTERA)										
Heptagenia	1	-	-	-	-	-	-	-	1	-
Rithrogena	32	9	-	196	9	-	12	34	1	1
Iron	-	7	-	-	-	-	-	-	-	-
Ironopsis	-	24	-	-	-	-	-	-	-	-
Cinygmula	-	4	1	-	-	-	-	-	-	-
Isonychia	-	-	-	-	3	-	-	-	1	-
Paraleptophlebia	12	25	31	1	-	-	1	-	-	-
Ephemerella	4	248	11	9	-	-	-	-	-	-
Tricorythodes	-	-	-	1	2	14	4	10	23	25
Baetis	68	188	102	45	34	39	22	287	131	244
STONEFLIES (PLECOPTERA)										
Pteronarcys	-	1	-	1	1	2	1	1	-	-
Nemoura	1	2	2	-	1	-	-	-	-	-
Capnia	6	-	54	2	-	-	-	17	27	30
Acroneuria	6	16	9	51	6	-	4	4	5	13
Arcynopteryx	29	5	8	7	1	-	1	2	2	1
Isogenus	4	1	-	15	2	1	5	8	-	-
Iseperla	-	-	1	-	-	-	-	-	-	-
Alloperla	1	6	-	-	-	-	-	-	-	-
CADDISFLIES (TRICHOPTERA)										
Hydropsyche	118	132	-	239	87	20	68	226	43	182
Cheumatopsyche	39	-	-	136	45	2	40	110	56	2
Arctopsyche	2	1	-	-	-	-	-	-	-	-
Rhyacophila	4	26	-	13	8	-	-	-	-	1
Glossosoma	1	22	1	-	-	-	-	-	-	-
Protoptila	-	-	-	-	-	-	1	-	-	-
Anagapetus	-	1	-	-	-	-	-	-	-	-
Neophylax	-	1	-	-	-	-	-	-	-	-
Helicopsyche	-	-	-	-	-	2	9	9	9	-
Lepidostoma	-	-	3	-	-	-	-	-	-	-
ALDERFLIES (SIALIDAE)										
Sialis	-	-	2	-	-	-	-	-	-	-
AQUATIC MOTHS (LEPIDOPTERA)										
Parargyractis	-	-	-	3	1	5	17	3	10	4
DRAGONFLIES (ANISOPTERA)										
Ophiogomphus	-	-	-	4	1	2	4	1	2	-
DAMSELFLIES (COENAGRIONIDAE)	-	-	-	-	1	-	-	-	1	1
WATER PENNIES (PSEPHENIDAE)	1	-	-	2	1	1	2	1	1	-
RIFFLE BEETLES (ELMIDAE)	20	1	-	130	31	64	116	173	149	170
PREDACEOUS DIVING BEETLES (DYTISCIDAE)	-	-	-	-	-	-	-	-	-	1
CRANE FLIES (TIPULIDAE)	6	4	22	168	1	14	3	18	1	-
NET-WINGED MIDGES (BLEPHARICERIDAE)	-	2	-	-	4	-	1	-	1	-
BLACK FLIES (SIMULIIDAE)	6	1	44	29	15	40	2	15	1	10
TRUE MIDGES (CHIRONOMIDAE)	25	52	1260	92	28	52	54	64	38	264
SOLDIER FLIES (STRATIOMYIIDAE)	-	-	-	-	-	3	-	-	-	-
SNIPE FLIES (RHAGIONIDAE)	5	-	-	4	3	4	23	7	-	3
HORSE FLIES (TABANIDAE)	1	-	1	-	-	-	6	1	-	-
DANCE FLIES (EMPIDIDAE)	-	1	-	-	-	-	-	1	-	-
SNAILS (GASTROPODA)										
Conicbasis	-	-	-	-	-	5	-	-	2	1
Physa	-	-	35	-	3	2	-	-	-	-
Lymnaea	-	-	-	-	14	-	-	-	-	-
Gyraulus	-	-	-	-	-	3	-	-	-	-
Parapholyx	-	-	-	-	-	-	-	-	-	3
Lanx	-	-	-	-	-	8	-	-	3	-
CLAMS (SPHAERIIDAE)	-	-	2	-	-	-	-	-	-	-
Number of Kinds	23	26	20	21	25	20	23	23	23	20
Number in Sample	412	804	1671	1148	306	285	398	996	543	946

TR = Trinity River, NFT = North Fork Trinity. HC = Hayfork Creek, SFT = South Fork Trinity, KR = Klamath River

Table 4: Physical and Chemical Conditions, Trinity River, May, 1968

	TR above Coffee Creek	Coffee Creek	TR at Lewiston	NFT near Helena	TR near Burnt Ranch	HC near Hyampom	SFT near Hyampom	SFT near Salyer	TR at Weitchpec
Date	5/20	5/20	5/20	5/21	5/21	5/21	5/21	5/21	5/23
Time	1230	1100	1830	1630	1815	1200	1100	2000	0930
Temperature (°C)	-	8.0	11.0	12.0	14.0	14.0	10.0	14.0	14.0
Velocity (approx.ft/sec)	2	5	1	2	1	1	2	2	3
Settleable Solids (ml/l)	.03	.04	<.01	.01	.02	.01	.03	.03	.05
Conductivity (µmohs)	75	70	100	65	110	280	195	210	160
TDS (mg/l)	55	50	60	30	60	160	105	130	100
Hardness as Ca (mg/l)	13.5	10.0	15.5	10.0	17.5	46.5	28.5	36.0	26.5
DO (ml/l)	10.4	11.0	11.6	10.6	10.8	10.4	10.4	11.0	10.4
pH	7.8	7.7	8.7	7.7	7.9	8.5	8.1	8.2	7.2
NO_3-N as N (mg/l)	<.02	.02	<.02	<.02	<.02	<.02	<.02	<	<.02
NH_3-N as N (mg/l)	.07	.19	<.05	.07	<.05	<.05	<	.05	.16
Org-N as N (mg/l)	.19	.61	.11	.02	.08	.013	.54	.15	.54
PO_4-P as P (mg/l)	<.003	.003	.017	<.003	.007	.010	.017	.020	.013
Total-P as P (mg/l)	.035	.055	.035	<.02	.02	<.02	.065	.065	.075
Na (mg/l)	.9	1.5	2.6	1.2	2.8	7.2	3.3	4.8	3.3
Boron (mg/l)	<.10	-	-	<.10	-	<.10	<.10	<.10	-
K (mg/l)	.2	.4	.4	.2	.4	.6	.4	.6	.5

Table 5: Physical and Chemical Conditions, Trinity River, August, 1968

	TR above Coffee Creek	Coffee Creek	TR at Lewiston	NFT near Helena	TR near Burnt Ranch	HC near Hyampom	SFT near Hyampom	SFT near Salyer	TR at Weitchpec
Date	8/6	8/6	8/6	8/6	8/6	8/5	8/5	8/7	8/7
Time	1330	0945	1500	1700	1850	1645	1430	0830	1245
Temperature (°C)	18.0	15.5	14.0	24.5	23.5	26.0	24.5	19.5	23.0
Velocity (Approx. ft/sec)	-	-	-	-	-	-	-	-	-
Settleable Solids (ml/l)	<.01	.01	<.01	<.01	<.01	.02	.02	.01	.01
Conductivity (µmohs)	280	160	98	120	165	300	280	300	240
TDS (mg/l)	105	95	60	70	100	175	170	180	140
Hardness as Ca (mg/l)	31.0	-	-	21.0	-	50.5	53.0	-	42.5
DO (ml/l)	9.0	9.0	11.2	8.8	8.7	11.0	6.8	8.4	9.0
pH	8.4	8.4	8.9	8.9	8.7	8.9	8.4	8.2	8.3
NO_3-N as N (mg/l)	<	<	<	<	<	<	<	<	<
NH_3-N as N (mg/l)	.07	<	.18	.05	.16	.05	.09	.05	.09
Org-N as N (mg/l)	.12	.010	.24	.10	.23	.23	.22	.23	.17
PO_4-P as P (mg/l)	.013	.010	.017	.020	.013	.037	.02	.037	.010
Total-P as P (mg/l)	<.02	<	.035	.085	.045	.115	.020	.090	.065
Na (mg/l)	.9	1.5	2.6	2.0	-	10.0	4.7	-	4.5
Boron (mg/l)	<.10	-	-	.10	-	<	.12	.15	<
K (mg/l)	.2	.4	.4	.5	-	.7	.7	-	.9
Chlorophyll (Fluorescence)	2.2	1.84	4.0	1.8	2.36	3.2	1.56	1.4	-

Table 6: Physical and Chemical Conditions, Trinity River, October, 1968

	TR above Coffee Creek	Coffee Creek	TR at Lewiston	NFT near Helena	TR near Burnt Ranch	HC near Hyampom	SFT near Hyampom	SFT near Salyer	TR at Weitchpec
Date	10/15	10/15	10/14	10/16	10/16	10/15	10/15	10/16	10/16
Time	1640	1510	1650	0740	1020	1055	0925	1300	1805
Temperature (°C)	11.0	11.0	12.0	9.5	11.0	12.5	13.5	14.5	15.0
Velocity (Approx. ft/sec)	-	-	-	-	-	-	-	-	-
Settleable Solids (ml/l)	.07	.03	.02	.02	.03	.01	.06	.03	.08
Conductivity (μmohs)	175	160	95	105	145	350	300	310	220
TDS (mg/l)	105	115	105	70	95	210	180	215	130
Hardness as Ca (mg/l)	31	-	-	19.5	-	56.5	54	-	37.5
DO (ml/l)	10.2	10.4	11.0	10.6	10.4	11.6	9.8	10.0	10.0
pH	8.0	8.1	8.0	7.8	7.9	8.3	8.1	8.1	7.8
NO_3-N as N (mg/l)	<	<	<	<	<	<	<	<	<
NH_3-N as N (mg/l)	<	.08	<	.13	<	.07	<	<	.15
Org-N as N (mg/l)	.14	.4	.28	.19	.15	.33	.08	.16	.19
PO_4-P as P (mg/l)	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.02	<.01
Total-P as P (mg/l)	<.02	<.02	<	<.02	.02	.02	.04	.05	.05
Na (mg/l)	4.1	-	-	1.9	-	14.	5.6	-	4.8
Boron (mg/l)	<	-	-	<	-	.13	<	<	.12
K (mg/l)	.3	-	-	.3	-	.6	.5	-	.7
Chlorophyll (Fluorescence)	1.85	7.0	4.4	1.5	2.55	2.2	2.4	3.35	3.65

Table 7: Klamath River Benthic Samples - August, 1968

Station #	18	15	13	11	10	A	8	7	6	9	17	5
FLATWORMS (TURBELLARIA)	8	51	-	-	-	-	-	-	-	-	-	3
SEGMENTED ROUNDWORMS (OLIGOCHAETA)	16	1	-	48	-	-	-	-	-	-	1	-
LEECHES (HIRUDINEA)	-	-	-	1	-	-	-	-	-	-	-	-
SCUDS (AMPHIPODA)												
Hyalella	32	2	-	-	-	-	-	-	-	-	-	-
WATER MITES (HYDRACARINA)	-	-	-	-	-	-	-	-	1	-	-	-
MAYFLIES (EPHEMEROPTERA)												
Iron	-	1	-	-	1	7	26	-	1	-	16	6
Ironopsis	-	-	-	-	-	-	-	6	-	-	21	4
Cinygmula	-	-	-	-	-	-	-	3	-	-	44	-
Ironodes	-	-	-	-	-	-	-	-	-	-	2	-
Siphlonurus	-	-	-	-	-	-	13	-	-	-	-	-
Centroptilum	-	-	-	-	-	-	-	-	-	-	6	1
Isonychia	-	-	-	-	-	-	3	-	526	15	-	-
Ephemerella	84	1	3	48	10	1	46	3	16	42	9	17
Tricorythodes	120	9	12	21	54	43	9	-	6	1	-	-
Baetis	128	41	3	352	74	-	87	238	64	68	4	2
Paraleptophlebia	-	-	-	-	-	-	-	-	-	-	3	1
Heptagenia	-	-	-	-	-	-	-	-	-	7	-	-
STONEFLIES (PLECOPTERA)												
Pteronarcys	-	1	-	-	-	-	-	-	-	-	-	-
Nemoura	-	-	-	-	-	-	-	-	-	-	-	-
Acroneuria	4	1	2	3	-	3	1	4	6	4	2	-
Isoperla	-	-	-	-	-	-	-	-	-	-	-	3
Arcynopteryx	-	-	-	-	-	1	-	-	-	-	-	-
Alloperla	-	-	-	-	-	-	-	-	1	1	-	-
Chloroperlinae	-	-	-	-	-	-	-	-	-	-	-	1
Isogenus	-	-	-	-	-	-	-	-	-	1	-	-
CADDISFLIES (TRICHOPTERA)												
Wormaldia	-	-	-	-	4	-	-	2	8	28	-	-
Hydropsyche	248	33	20	1848	33	25	162	32	80	35	28	23
Cheumatopsyche	8	5	2	-	2	1	9	-	-	38	2	1
Rhyacophila	-	-	5	-	-	7	-	16	1	3	8	-
Glossosoma	-	8	5	-	2	-	1	1	-	-	2	13
Protoptila	-	-	-	-	-	-	-	1	2	-	-	-
Micrasema	56	-	-	39	-	-	2	-	-	-	-	-
Hydroptila	40	1	-	2	-	-	1	2	2	-	-	-
Leucotrichia	8	-	-	-	-	-	-	-	-	-	6	-
Lepidostoma	-	-	-	-	-	-	-	-	-	-	-	-
Leptocella	-	-	-	1	-	-	-	-	-	-	-	-
Nystacides	-	1	-	5	-	-	-	-	-	-	-	-
Helicopsyche	8	5	-	56	6	-	-	-	-	1	-	-
Neophylax	-	-	-	-	-	-	-	-	-	-	2	-
Dicosmoecus	-	4	4	-	-	-	-	-	-	-	-	-
Polycentropus	-	-	-	-	-	-	-	-	-	1	-	-
DRAGONFLIES (ANISOPTERA)												
Ophiogomphus	4	-	-	8	2	-	-	-	2	-	-	-
DAMSELFLIES (ZYGOPTERA)												
AGRIONIDAE	-	4	-	-	-	-	-	-	-	-	-	-
COENAGRIONIDAE	8	3	-	-	-	-	-	-	-	-	-	-
SPONGILLA FLIES (SISYRIDAE)												
Climacia	-	1	-	-	-	-	-	-	-	-	-	-
AQUATIC MOTHS (PYRALIDIDAE)												
Parargyractis	12	4	7	3	4	-	-	-	12	-	-	-
WATER BOATMEN (CORIXIDAE)	-	-	-	16	-	-	12	-	-	-	-	-
PREDACEOUS DIVING BEETLES (DYTISCIDAE)	-	-	-	-	-	-	-	-	1	-	-	-
RIFFLE BEETLES (ELMIDAE)	-	98	4	8	4	-	5	6	9	3	1	-
WATER PENNIES (PSEPHENIDAE)	-	7	-	-	-	-	-	-	-	-	-	-
CRANE FLIES (TIPULIDAE)	20	-	2	64	-	3	11	3	14	2	-	4
NET-WINGED MIDGES (BLEPHAROCERIDAE)	-	-	-	-	-	-	1	61	3	-	-	-
MOUNTAIN MIDGES (DEUTEROPHLEBIIDAE)	-	-	-	-	-	-	-	4	-	-	-	-
BLACK FLIES (SIMULIIDAE)	120	2	-	88	-	42	2	2596	24	1	3	-
TRUE MIDGES (CHIRONOMIDAE)	316	57	26	4000	-	206	164	114	87	86	12	13
SOLDIER FLIES (STRATIOMYIIDAE)	36	-	-	2	-	-	-	-	-	-	-	-
SNIPE FLIES (RHAGIONIDAE)	-	-	2	40	-	-	8	6	5	1	-	-
LONG-LEGGED FLIES (DOLICHOPODIDAE)	8	-	-	-	-	-	-	-	-	-	-	-
DANCE FLIES (EMPIDIDAE)	-	2	-	-	-	-	-	3	3	-	-	-
SNAILS (GASTROPODA)												
Gonidea	-	-	-	24	-	-	-	-	4	-	-	-
Physa	8	4	-	24	-	-	-	-	-	-	-	-
Cyrnulus	-	1	-	32	-	-	1	-	-	-	-	-
Lymn	40	1	4	24	-	-	-	-	-	-	-	-
Parapholyx	160	-	-	320	-	-	-	-	-	-	-	-
Fluminicola	76	-	-	-	-	-	-	-	-	-	-	-
Number of Kinds	25	28	15	26	12	11	20	20	24	20	19	14
Number in Sample	1568	369	111	7077	196	339	565	3114	878	339	189	92

Station #'s: 18 = Klamath River at Klamathon
15 = Shasta River near Conf. Klamath River
11 = Klamath River at Seiad Valley
10 = Klamath River at Happy Camp
A = Indian Creek near Happy Camp
8 = Klamath River at Orleans
7 = Bluff Creek near conf. of Klamath River
6 = Klamath River at Weitchpec
9 = Salmon River at Somes Bar
17 = Little Shasta near Montague
13 = Scott River near conf. Klamath River
5 = Shasta River at Edgewood

Table 8: Smith River, August, 1968

	Smith River at Jed. Smith Park	Middle Fork Smith at Gasquet	South Fork Smith at Gage	Goose Creek
MAYFLIES (EPHEMEROPTERA)				
Heptagenia	-	-	2	3
Iron	-	3	1	5
Ephemerella	1	6	5	6
Baetis	31	23	21	20
Siphlonurus	-	-	-	1
STONEFLIES (PLECOPTERA)				
Pteronarcys	-	1	-	-
Nemoura	-	1	-	-
Acroneuria	-	4	2	4
Arcynopteryx	-	-	1	1
CADDISFLIES (TRICHOPTERA)				
Wormaldia	2	-	-	2
Hydropsyche	-	17	4	10
Cheumatopsyche	158	1	-	-
Rhyacophila	7	5	7	-
Glossosoma	3	-	-	-
Protoptila	-	1	-	-
Hydroptila	5	-	-	-
Neophylax	-	-	-	6
Dicosmoecus	-	-	-	3
BEETLES (COLEOPTERA)				
RIFFLE BEETLES (ELMIDAE)	-	4	-	11
TRUE FLIES (DIPTERA)				
CRANE FLIES (TIPULIDAE)	4	5	1	29
NET-WINGED MIDGES (BLEPHARICERIDAE)	15	8	19	-
MOUNTAIN MIDGES (DEUTEROPHLEBIIDAE)	-	-	1	-
BLACK FLIES (SIMULIIDAE)	104	40	30	1
TRUE MIDGES (CHIRONOMIDAE)	76	118	22	102
SOLDIER FLIES (STRATIOMYIIDAE)	-	-	1	-
DANCE FLIES (EMPIDIDAE)	1	1	-	-
Number of Kinds	12	16	15	15
Number in Sample	407	238	118	204

Table 9: Selected Chemical and Physical Data, by Station, Klamath Basin, May, 1968

	KR-Orleans 8	Sal R 9	KR-HC 10	IC-HC A	KR-Seaid 11	Scott R-KR 13	Shasta R-KR 15	KR-Klam 18
Date	5/22/68	5/23/68	5/22/68	5/22/68	6/26/68*	5/22/68	5/23/68	5/23/68
Time	1030	1230	1300	0800	0930	1600	1415	0950
Temperature (°C)	14.5	11.5	18	8	20	14	17.5	15
Velocity (fps)	2500	3	2500	400	--	200	2	1000
Turbidity JTU	--	--	--	0	--	--	--	--
Settleable Solids (mg/l)	0.03	0.02	0.02	0.01	--	0.03	0.02	0.01
Conductivity (μmohs)	122	70.0	143	98	220	143	610	177
TDS, (mg/l)	80	45	95	60	175	95	410	125
Hardness as Ca (mg/l)	18.5	--	22.0	18.5	31.5	27.5	98	20.0
DO (ml/l)	10.70	11.0	10.2	11.05	7.2	10.15	9.0	10.65
pH	8.21	7.5	8.8	7.65	7.8	7.3	8.7	7.92
NO_3-N (mg/l)	0.04	<0.02	0.03	<0.02	0.04	0.20	<0.02	0.07
NH_3-N (mg/l	<	<0.05	0.05	0.08	0.07	0.05	<0.05	0.06
Org -N (mg/l	0.18	0.17	0.14	0.26	0.59	0.20	0.46	0.40
PO_4-P mg/l	0.013	0.003	0.023	<0.003	0.043	<	0.190	0.08
Total P (mg/l)	0.055	0.070	0.050	0.020	0.070	0.034	0.200	0.11
Na (mg/l)	4.7	1.7	8.8	1.7	17	2.6	48	14
Boron (mg/l)	--	--	0.10	0.10	--	--	0.68	--
K (mg/l)	0.9	0.6	0.9	0.4	--	0.8	3.9	2.1
Chl Fu**	12.6	2.1	12.0	1.2	--	14.4	24.6	36.0
Weight (mg/m^3)	8.6	1.5	8.4	0.8	--	10.0	17.2	25.0

* Only June data available

** Fu = Fluorescence units

Table 10: Selected Chemical and Physical Data, by Station, Klamath Basin, August, 1968

	KR-Orleans 8	Sal R 9	KR-HC 10	IC-HC A	KR-Seaid 11	Scott R-KR 13	Shasta R-KR 15	KR-Klam 18
Date	8/7/68	8/7/68	7/30/68*	*	7/31/68*	8/8/68	8/13/68	*
Time	1650	1940	1315		0800	1355	1200	*
Temperature (°C)	--	23	25		23	23	22	*
Velocity (fps)	--	--	--		--	--	--	*
Turbidity JTU	--	--	--		--	--	20	*
Settleable Solids, (mg/l)	--	--	0.02		0.01	--	0.02	*
Conductivity (µmohs)	225	160	190		230	260	700	*
TDS (mg/l)	--	--	110		180	--	450	*
Hardness as Ca (mg/l)	--	--	32		29.5	--	110	*
DO (ml/l)	--	--	9.2		--	--	--	*
pH	8.85	8.35	8.6		7.6	8.95	8.3	*
NO_3-N (mg/l)	--	--	<		<	--	<	*
NH_3-N (mg/l)	0.31***	0.1***	0.07		0.10	0.14***	0.05	*
Org-N (mg/l	--	--	0.23		0.46	--	0.41	*
PO_4-P (mg/l)	--	--	0.033		0.15	--	0.207	*
Total P(mg/l)	--	--	0.060		0.195	--	0.255	*
Na (mg/l)	--	--	4.5		16	--	48	*
Boron (mg/l)	--	--	0.15		0.25	--	0.69	*
K (mg/l)	--	--	1.2		2.6	--	4.5	*
Chl. Fu	8.75	1.2	8.75**		10	6.45	4.7	4.6
mg/m^3	6.1	0.8	6.1		7.0	4.5	3.3	3.2

* No August data available

** From 8/8/68 (time not given)

*** Nitrogen expressed as total Kjeldahl nitrogen

Table 11: Selected Physical and Chemical Data, by Station, Smith River
May, 1968

	SR-Jed	MFS	SFS	GC
Date	5/20/68	5/21/68	5/20/68	Road Closed**
Time	1400	0930	1715	
Temp. (°C)	15	12.5	13	
Velocity (fps)	1600	900	900	
Turbidity JTU	20	10	25	
Settleable Solids (mg/l)	0.02	0.01	0.01	
Conductivity (μmohs)	116	120	104	
TDS (mg/l)	75	60	75	
Hardness as Ca (mg/l)	19.0	20.0	17.0	
DO (ml/l)	10.6	10.35	10.45	
pH	7.9	7.9	8.05	
NO_3-N (mg/l)	<	<	< 0.02	
NH_3-N (mg/l)	0.08	0.19	< 0.05	
Org-N (mg/l)	0.10	0.48	0.11	
PO_4-P (mg/l)	0.003	0.003	< 0.003	
Total P (mg/l)	0.020	<	0.075	
Na (mg/l)	2.0	5.8	1.7	
Boron (mg/l)	-	-	-	
K (mg/l)	0.03	0.02	0.04	
Chl. Fu*	5.1	1.8	1.8	
Wt. mg/m^3	3.6	1.3	1.3	

* Fu = Fluorescence units

** Data unavailable

Table 12: Chlorophyll Levels, by Station, Smith River, August, 1968

	SR-Jed 1	MFS 2	SFS 3	GC 4
Date	8/7/68	8/6/68	8/6/68	8/6/68
Time	0710	*	*	*
Chl. Fu	0.87	0.7	0.64	0.6
mg/m^3	0.61	0.5	0.45	0.4

* Data unavailable

APPENDIX 3

BACKGROUND INFORMATION DESCRIBING ANIMALS OBSERVED IN SURVEYS

The classifications and information given (except as noted) are abstracted from Pennak (12).

In the first part of this appendix the organisms are classified taxonomically with both the Latin names and the common names given. In the second part the organisms are listed alphabetically by common name. Information about pollution tolerance and the length of the aquatic life cycle is included also in the second part of the appendix. Reference numbers in parentheses are those indicated for articles listed in the Bibliography Section of the main text.

Appendix 3, Part 1

Phylum Annelida (segmented worms)
- Class Hirundinea (leeches)
- Class Oligochaeta (aquatic earthworms)

Phylum Arthropoda
- Class Arachnoidea (spiders, mites, etc.)
  - Order Hydracarina (water mites)
- Class Crustaceae
  - Order Amphipoda (scuds)
  - Order Decapoda (crayfish, shrimp)
    - Family Astacidae (crayfish)
- Class Insecta
  - Order Coleoptera (beetles)
    - Family Dytiscidae (predaceous diving beetles)
    - Family Elmidae (riffle beetles)
    - Family Psephenidae (water pennies)
  - Order Diptera
    - Family Blepharoceridae (net-winged midges)
    - Chironomidae [Tendipidae] (midges)
    - Deuterophlebiidae (mountain midges)
    - Dolichopodidae (Usinger - long-legged flies)
    - Empididae (Usinger - dance flies)
    - Heleidae (biting midges)
    - Muscidae (house flies)
    - Rhagionidae (snipe flies)
    - Simuliidae (black flies)
    - Stratiomyiidae (soldier flies)
    - Tabanidae (horse flies)
    - Tipulidae (crane flies)
  - Order Ephemeroptera (mayflies)
  - Order Hemiptera
    - Family Corixidae (water boatmen)
    - Family Naucoridae (creeping water bugs)
  - Order Lepidoptera (moths, butterflies)
  - Order Megaloptera
    - Family Sialidae (alderflies)
  - Order Neuroptera
    - Family Sysridae (spongilla flies)
  - Order Adonata
    - Suborder Anisoptera (dragonflies)
    - Suborder Zygoptera (damselflies)
      - Family Coenagrionidae
  - Order Plecoptera (stoneflies)
  - Order Trichoptera (caddisflies)

Appendix 3, Part 1 cont'd:

Phylum Mollusca
- Class Gastropoda (snails, limpets)
- Class Pelecypoda (clams, mussels)
  - Order Heterodonta
    - Family Sphaeriidae (fingernail clams)

Phylum Platyhelminthes
- Class Turbellaria (flatworms)

Alderflies (Sialidae)

The larval stage may last two to three years. The larvae breathe through gills.

* * * * *

Beetles (Coleoptera)

Adult beetles usually carry atmospheric oxygen with them, so they are not dependent upon the dissolved oxygen in water. The larvae may have gills; usually respiration is through spiracles (from surface air) and through body integument.

* * * * *

Black flies (Simuliidae)

Depending upon species and habitat there may be one to several generations per year. The larval stage may last two to six weeks; the pupal stage is shorter - two to eight days. Pollution tolerance is not stated.

* * * * *

Caddisflies (Trichoptera)

The adult stage lasts about 30 days or less; the greatest portion of a caddisfly's life is spent as a larva (overwintering form is larval). Respiration is through the whole body surface (some species have gills, in addition).

* * * * *

Crane flies (Tipulidae)

Habitat depends upon the species. Larvae of most species can respire through spiracles on a disc, which may be pushed above the water surface at

times of low dissolved oxygen. There is usually one generation per year - some species may have more. Larval stages may extend from one month to one year depending upon species and environment.

* * * * *

Creeping water bugs (Naucoridae)

These animals carry their oxygen supply under their wings; hence, they are not dependent upon the D.O. level of the water.

* * * * *

Damselflies (Zygoptera)

Nymphs breathe through gills. The nymph stage may last a long time (11 - 14 instars). The length depends upon species, temperature and food.

* * * * *

Dance flies (Empididae)

Various genera are described in Usinger (16). Life-cycle length and pollution tolerance are not stated.

* * * * *

Dragon flies (Anisoptera)

See Damselflies.

* * * * *

Fingernail clams (Sphaeriidae)

According to Pennak (12), the Sphaeriidae may be "found on all types of bottoms except rock and clay". Respiration is through gills. Ingram (8) states that certain Sphaeriidae are found in low-D.O. areas (as well as in high-D.O. ones): Pisidium and Musculium. Sphaeriidae usually live 12-18 months.

Flatworms (Turbellaria)

The Planarian group need lots of oxygen. The Rhabdocoels can live in conditions of low oxygen tension. In the laboratory turbellarians have lived for several weeks or months - up to a year. Certain cultures which can undergo fission (as a means of reproduction) have been maintained in laboratories two to eleven years (12).

* * * * *

Horse flies (Tabanidae)

Some of the flies in this family have aquatic larvae. Although the time period is variable, the larval stage may last three years.

* * * * *

House flies (Muscidae)

Eggs are laid usually in manure piles, but the eggs may also be deposited in decaying vegetation or animal matter. Larvae exist in the same surroundings - so their appearance in unpolluted water would be extremely rare.

* * * * *

Leeches (Hirundinea)

Freshwater species respire through the entire body surface. Their tolerance to low dissolved oxygen is unknown. According to Ingram and Towne (9), certain leeches can survive in a sludge substrate. In reference (13) the following leeches are considered pollution-tolerant: Dina parva, and Glossiphonia sp.

Long-legged flies (Dolichopodidae)

Various genera are described in Usinger (16). Length of life cycle and tolerance to pollution are not given.

* * * * *

Mayflies (Ephemeroptera)

The nymphs breathe through gills and through body surface. Although few life histories are known, it is thought that mayflies live one year, primarily in the nymph stage. Certain authors (2), (8), (9), classify mayflies as clean-water organisms. Others (13) state that mayflies in the Family Heptagenidae are clean-water types, whereas Baetidae and Tricorythodes sp. are of medium tolerance to pollution. Day, in Usinger (16), says that Ephemerella sp. may be found on silt bottoms of streams or among trash and debris.

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Moths (aquatic) (Lepidoptera)

Lepidoptera usually overwinter in the larval stage. Pollution tolerance is not given.

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Mountain midges (Deuterophlebiidae)

Neither Pennak (12) nor Usinger(16) describes pollution tolerance or length of life cycle.

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Net-winged midges (Blepharoceridae)

No generation time is given. Tolerance to pollution is not stated.

Roundworms (Oligochaetes)

Members of the Family Tubificidae are found usually in polluted water. Some have a red pigment in the blood. These worms can survive for long periods in anaerobic conditions, but not indefinitely. Some genera build tubes attached to the bottom substrate; the posterior section of the animal protrudes from the tube and waves about in the water (it is thought that increased oxygen can be absorbed from the water by means of this activity).

Authors vary in their statements about roundworms and pollution-tolerance: Oligochaetes (including Limnodrilus sp.) are pollution-tolerant (13); sludgeworms are pollution-tolerant [can be found in water with D.O. = 0.5 ml/l] (2); sludgeworms, Tubifex tubifex, are pollution-tolerant (8); sludgeworms (Tubifex and Limnodrilus) may be found on a sludge substrate (9).

* * * * *

Scuds (Amphipoda)

Scuds are gill-breathers and are usually found in an unpolluted environment with a high level of dissolved oxygen (the one exception is Pontoporeia affinis). Most amphipods complete their life cycle within one year (Pontoporeia affinis takes longer).

* * * * *

Snails (Gastropoda)

Snails may respire either through gills or through a polmonary cavity. Of the genera observed, five have pulmonary cavities (Physa, Lymnaea, Gyraulus, Parapholyx, Lanx), while two (Flumincola and Goniobasis) are gill-breathers. Classically, the gill-breathing snails

are considered sensitive to low-oxygen conditions, however Pennak (12) states that only rarely can any snail survive low oxygen levels for more than 48 hours (under experimental conditions). Some authors consider certain snails to be of medium tolerance to pollution: Ferrissia sp. (13). Fluminicola fusca (13), Parapholyx sp. (13), Lymnaea (8), Physa (8), Planorbis (8). Of the genera listed Physa is the most tolerant of pollution (8).

* * * * *

Snipe flies (Rhagionidae)

Aquatic larvae breathe through gills. Generation time is not given.

* * * * *

Soldier flies (Stratiomyiidae)

Larvae may stay under the water a long time, using oxygen stored in the tracheal system. Generation time is not given.

* * * * *

Spongilla flies (Sisyridae)

The larvae of these flies are parasitic on fresh-water sponges. Respiration may be through either gills or cuticle, depending upon stage of life cycle. There may be several generations per year. Usinger (16) reports one study in which, within the study area, only Climacia sp. was found in a cool, clean lake and only Sisyra sp. was found in a relatively warm, polluted pond (both waters contained sponges, (Spongilla sp.).

* * * * *

Stoneflies, (Plecoptera)

Nymphs breathe through gills usually (also through the body surface).

Nymph stage may extend for one to three years. Stoneflies are considered clean-water organisms by many authors (2), (8), (9).

* * * * *

True midges (Chironomidae [also Tendipidae])

There may be one-half to two generations per year. Usinger (16) says that "some species in warm water may have a number of generations per year". The larvae of the most abundant species (this group is the red midges) can tolerate low dissolved oxygen levels, since they have a respiratory pigment (erythrocruorin) dissolved in their blood. Red midges are considered pollution-tolerant (2), (8), (13), while the green midges are either clean-water organisms or those of medium tolerance to pollution (13).

* * * * *

Water boatmen (Corixidae)

Pennak (12) states that the body of this bug is surrounded by a "film of air" which is renewed whenever the animal rises to the surface of the water. Habitats of the water boatmen may vary depending upon species - the ranges include brackish to saline water and fresh to septic ponds (16). The length of the life cycle is not stated.

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Water mites (Hydracarina)

Little is known about the life cycles for these animals. The life histories are described only for a few species. Oxygen used in respiration seems to be absorbed through the body surface. Their tolerance to pollution is not stated.